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Japanese Published Unexamined (Kokai) Patent Publication No. S59-70769; Publication Date: April 21, 1984; Application No. S57-180282; Application Date: October 13, 1982; Int. Cl.^{3}: C23C 13/00 G03G 5/082; Inventor: Yasuo Konishi; Applicant: Nippon Denki Home Electronics Co., Ltd.; Japanese Title: Jouchaku Houhou (Vapor Deposition Method)

Specification

Title of Invention

Vapor Deposition Method

Claim

A vapor deposition method wherein substances arranged in a crucible are evaporated by radiating an electron beam to be vapor-deposited on a substrate arranged above, characterized in that a means for heating the substances is provided; by using the heating means, all the substances are heated to a predetermined temperature to reduce the difference in the temperatures between a radiation area and a non-radiation area by the electron beam in the vapor deposition operation.

Detailed Description of the Invention

Field of Industrial Application

This invention pertains to a vapor deposition method. More specifically, this invention relates to a vapor deposition method for low heat conductive substance to be a material for an insulating film and an emission layer of a thin film electroluminescent lamp.

Technical Background

An electroluminescent lamp basically has a structure such that an emission layer is arranged between a pair of electrodes in which at least one electrode is transparent. There are two types of electroluminescent lamps: an inorganic type using a conventional iron plate as one electrode; an organic type using a plastic film. As both types do not sufficiently demonstrate a high luminescent brightness, the field of application is limited. Accordingly, in the recent years, a thin film electroluminescent lamp with a significantly improved luminescent brightness by increasing the charge voltage by forming an emission layer by an emission layer by an electron beam vapor deposition has been gaining the popularity.

Fig.1 is a cross-sectional view illustrating a thin film electroluminescent lamp having double insulating film structure. In the drawing, reference number 1 refers to a transparent glass substrate in which a transparent conductive film 2 made of indium oxide or tin oxide is formed on one surface thereof. Reference number 3 refers to a primary insulating film that is formed on the transparent conductive film 2, except for on one portion, and that is, for example, made of yttrium oxide; 4 to an emission layer that is formed on the primary insulating film 3, except for on the circumference,. and that is, for example, made of a manganese activation zinc sulfide phosphor; 5 to a secondary insulating film that is formed on the emission layer 4, whose circumference is overlapped on the primary insulating film 3, and that is, for example, made of yttrium oxide; 6 to a back electrode that is formed on the secondary insulating film 5 into an almost same size as that of the emission layer 4 and that is, for example, made of aluminum.

The thin film electroluminescent lamp having the double insulation structure is formed as follows. The transparent conductive film 2 is formed on the glass substrate 1 being heated in advance by spraying an indium solution or the like. After this, the primary insulating film 3, the emission layer 4, the secondary insulating film 5 and the back electrode are formed on the transparent conductive film 2 in the order by a vapor deposition. A resistor heating means is also used for the forming by the vapor deposition, but an electron beam means is often used.

More specifically, as shown in Fig.2, at the electron beam vapor deposition, a glass substrate 1 with the transparent conductive film 2 formed is arranged on a crucible 7 at a predetermined interval in advance. Substances 3' to 6' to be vapor deposited, such as yttrium oxide, manganese activation zinc sulfide and aluminum, are placed in the crucible 7. By radiating an electron beam 9 projected from an electron gun 8 on the substances 3' to 6', a portion of the substances 3' to 6' is evaporated and splashed above to adhere an evaporated substance 10 onto the glass substrate 1, thereby forming each film.

In this case, when the electron beam 9 is radiated, being stationed only in one location of the substances 3' to 6', it is in a minute movement as that location alone is collectively ablated. However, if the substances are metals with good heat conductivity, such as aluminum, are used, both radiation area by the electron beam 9 and vicinity become a high temperature due to heat conduction. Even if the electron beam 9 is slightly moved, the growth speed of a vapor deposition layer does not significantly changes. In the formation of the primary and secondary insulating films 3 and 5 and the emission layer 4, as a significant temperature difference occurs between the radiation area by the electron beam 9 and the vicinity due to lower heat conductivity of the substances 3', 4 and 5', the

growth speed of the vapor deposition film largely fluctuates as shown in Fig.3 by a dashed line A. Thereby, the thickness of the vapor deposition film cannot be controlled in the vapor deposition period to make the control of the film thickness difficult. It causes to fluctuate the product quality and increase the first cost.

Disclosure of the Invention

The present invention is produced to eliminate the aforementioned disadvantages and offer a vapor deposition method that is capable of gradually uniformize the growth speed of a vapor deposition film of a low heat conductive substance such as an insulator or a phosphor by radiating an electron beam onto it.

In short, the invention is characterized in that a means for heating substances to be vapor-deposited is provided; all the substances are heated to a predetermined temperature by the heating means to reduce the difference in the temperatures between a radiation area and a non-radiation area by the electron beam in the vapor deposition operation.

In detail, as the difference in the temperatures between the radiation area and the non-radiation area by the electron beam is reduced by increasing all the substances accommodated and arranged in the crucible to the predetermined temperature by heating them by the heating means, the difference in the temperatures between the radiation area and the non-radiation area is similarly reduced even if the electron beam slightly moves so as to almost uniformize the growth speed of the vapor deposition film, thereby making it possible to control the film thickness in the vapor deposition period, making the formation of the insulating film and the emission layer for the thin film electroluminescent lamp extremely easy, and thus achieving an improved product quality and a lower first cost.

Best Approach to Carry Out the Invention

A working example of the invention is described hereinbelow with reference to the drawings.

Fig.4 is a schematic diagram illustrating a vapor deposition device to carry out the invention. The same reference number indicates the same component of Fig.2 except for the following points different from Fig.2. A heater 11 is arranged on the crucible 7 as an example of the heating means. By charging a conduction to the heater 11, the insulating all of substances 3' and 5' such as yttrium oxide and the phosphor substance 4' such as manganese added zinc sulfide are heated to a predetermined temperature. At this state, the electron beam 9 is radiated onto a portion of the substances 3' to 5' from the electron gun 8 to form an insulating film and an emission layer. The heating temperature of the substances 3' to 5' by the heater 11 varies by the types of the substances whereas the power of the electron beam is predetermined as needed according the heating temperature. For example, when the substances to be vapor deposited are yttrium oxide and a manganese added zinc sulfide phosphor, the power is predetermined as follows. Note that the size of the substances is predetermined at 35 mmϕ x 10 mmt and that the power of the electron beam 9 refers to the product of emission current and acceleration voltage during a vapor deposition.

Substances to be vapor deposited	Heating speed	Electron beam power
Y_2O_3	500°C	500 VA
ZnS; Mn	300°C	25 VA

The growth speed of the vapor deposition film in the case of yttrium oxide becomes as shown in Fig.3 by a solid line B, which is significantly uniformized in comparison with a doted line B of Fig.3 that does not perform a heating operation with the heater 11.

Fig.5 is a schematic diagram illustrating a vapor deposition device as in the other working example. The difference between Fig.5 and Fig.4 is a secondary electron gun 8a is provided as a heating means for the substances 3' to 5' other than the electron gun 8. By enlarging the diameter of an electron beam 9a of the electron gun 8, all the substances 3' to 5' are radiated.

Furthermore, an infrared beam heater can also be used as another heating means.

Brief description of the Drawings

Fig.1 is a cross-sectional view illustrating a thin film electroluminescent lamp; Fig.2 a schematic diagram illustrating a vapor deposition device used for prior art vapor deposition method; Fig.3 a characteristic view illustrating the growth speeds of vapor deposition films by prior art vapor deposition method and a vapor deposition method of the invention; Fig.4 and Fig.5 schematic diagrams illustrating vapor deposition devices used for carrying out the vapor deposition method of the invention as in different working examples.

1...Glass substrate

2...Transparent conductive film

3 and 5...Insulating films

4...Emission layer

7...Crucible

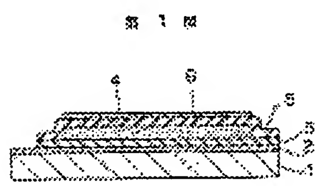
8...Electron gun

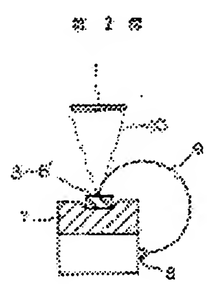
9 and 9a...Electron beams

3' to 5'...Substances to be vapor deposited

8a...Heating means (an electron gun)

11...Heating means (a heater)





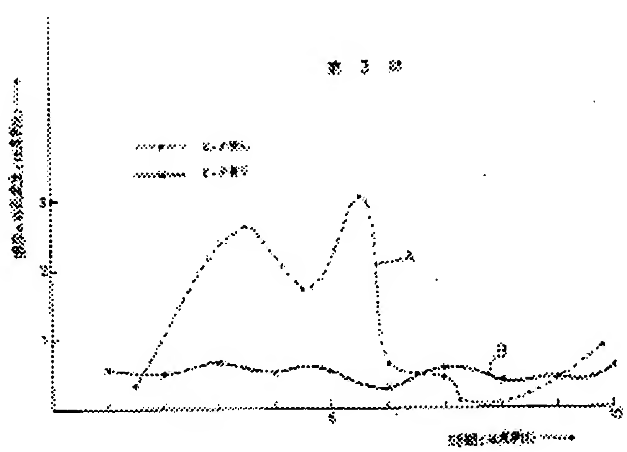
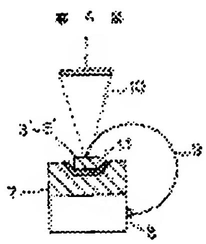
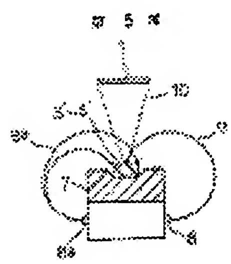


Fig.3:
Vertical axis: Growth speed of the film thickness (desired unit)

Horizontal axis: Time period (desired unit)
Dashed line: Absence of a heater
Solid line: Presence of the heater





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